Department of the Interior
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LANDSAT 5 THEMATIC MAPPER (TM) LOOKUP TABLE (LUT) RELEASE VERSION DESCRIPTION DOCUMENT (VDD)

Version 3

March 2004

LANDSAT 5 THEMATIC MAPPER (TM)
LOOKUP TABLE (LUT) RELEASE
VERSION DESCRIPTION DOCUMENT

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Executive Summary

This Lookup Table (LUT) Version Description Document (VDD) describes the contents of the LUT generated by the Image Assessment System (IAS) team. The IAS is responsible for offline assessment of image quality to ensure compliance with the radiometric and geometric requirements of the spacecraft and the Enhanced Thematic Mapper Plus (ETM+) sensor throughout the Landsat Mission. In addition to assessment functions, the IAS is responsible for the radiometric and geometric calibration of the Landsat 7 satellite and ETM+. The IAS also became responsible for the routine radiometric and geometric calibration of the Landsat 5 TM following its transition to bumper mode operations in early 2002.

This document describes the LUT created for the Landsat 5 TM and accompanies the release of LUTs for the Landsat Thematic Mapper (TM) sensor. The Landsat Ground Station Configuration Control Board (GCCB) controls this document.

Document History

Document Number	Document Version	Publication Date	Change Number	Keywords
IAS-223.1	Version 1	August 18, 2003		Original
IAS-223.2	Version 2	January 21, 2004		
IAS-223.3	Version 3	March 29, 2004		

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Section 1 Introduction

Effective May 5, 2003, Landsat 5 (L5) Thematic Mapper (TM) data processed and distributed by the U.S. Geological Society (USGS)/Earth Resources Observation System (EROS) Data Center (EDC) will be radiometrically calibrated using a new procedure and revised calibration parameters. The modified approach involves discontinuing the use of the Internal Calibrator (IC) for the reflective bands (with the exception of the thermal band) and implementing a time-dependent calibration LUT. This document details the LUTs released for the Landsat 5 TM sensor and the changes made for each release.

Section 2 LUT File Structure

The LUT has 11 (3+6+2) columns. The first three columns are time-related. The next five columns list the band average time-dependent gain coefficients generated from the lifetime gain equations. The last two columns provide band average icing-corrected gain coefficients for bands 5/7. See Table 2-1.

Table 2-1. LUT File Structure

Column	Description
Column 1	Days Since Launch (DSL)
Column 2	Decimal year since launch
Column 3	Day of the year (DOY)
Column 4	Discrete band 1 average gain coefficients
Column 5	Discrete band 2 average gain coefficients
Column 6	Discrete band 3 average gain coefficients
Column 7	Discrete band 4 average gain coefficients
Column 8	Discrete band 5 average gain coefficients
Column 9	Discrete band 7 average gain coefficients
Column 10	Discrete band 5 average gain coefficients (Icing correction)
Column 11	Discrete band 7 average gain coefficients (Icing correction)

Section 3 List of LUT in Effect

Table 3-1. lists all of the LUTs released. Note that the earlier LUTs released were during the testing phase on the development machine. This table lists only the official LUTs that went into the production system.

Table 3-1. LUT Versions and Release Dates

LUTs Version	Release Date
L5gain3a	May 5, 2003
L5gain4c	Sept 2003
L5gain5a	Jan 13, 2004
L5gain6a	April 5, 2004

Section 4 List of Changed Units

4.1 LUT File Structures

No Changes

4.2 Modifications to Existing LUT Values

The following sections list the changes made to the newly generated or modified LUTs.

4.2.1 File: L5gain1a

The L5gain1a is the first LUT created and has only 9 (3+6) columns. The band average gains were calculated from the lifetime gain equations. At this point, the icing corrections were not made to the reflective cold focal plane bands (bands 5/7).

4.2.2 File: L5gain2a

Icing corrections were implemented for bands 5/7 gain and were added as two new extra columns (Columns #10 and #11). The icing-corrected gain coefficients were generated by "multiplying" the lifetime gain coefficients with icing correction factors.

4.2.3 File: L5gain3a

An outgassing event took place on Dec 12, 2002 (DSL=6861), and the icing correction factors were updated to reflect this change.

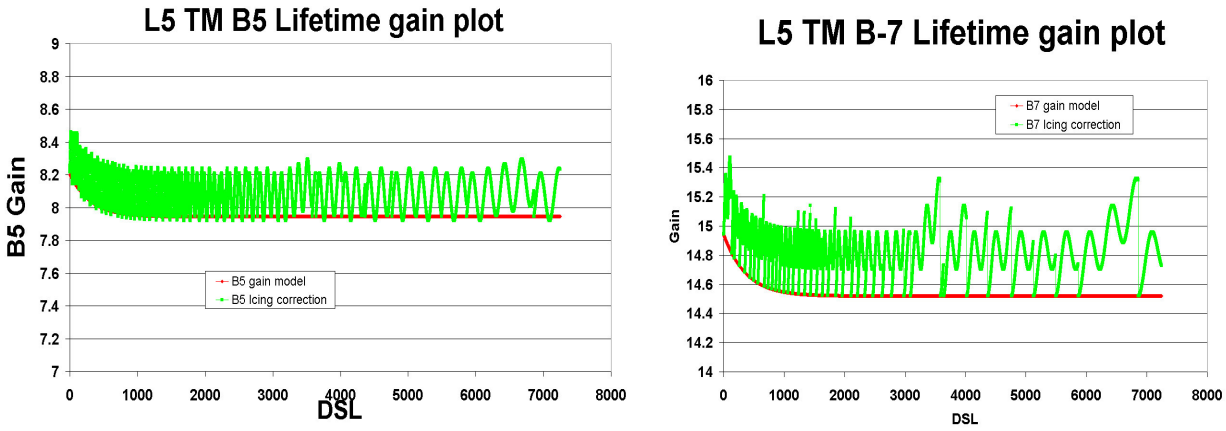

Figure 4-1. L5 TM Bands-5/7 lifetime gain plot (L5gain3a)

4.2.4 File: L5gain4a

The icing-corrected gain coefficients were generated by “dividing” the lifetime gain coefficients by icing correction factors. The updated icing corrected gain curve is a mirror image of the previous LUT gain curves from L5gain3a. The icing correction factors were slightly refined by updating the band 7 thin film model parameters.

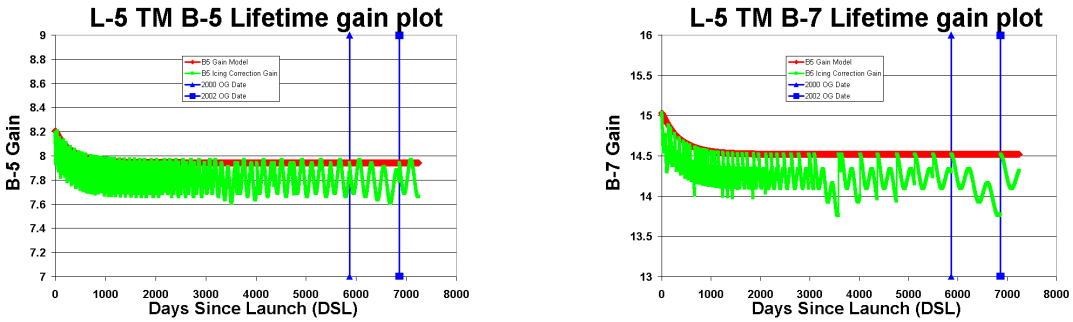

Figure 4-2. L5 TM Bands-5/7 lifetime gain plot (L5gain4a)

4.2.4.1 File: L5gain4b

The second column in the LUT contains the decimal year over the lifetime of the instrument. The fraction part of the year was slightly refined to get the true Day of the Year. (DOY)

4.2.4.2 File: L5gain4c

The second column in the LUT was slightly modified to account for the decimal year rollover that occurred on the last day of every year. The reason for this change was that the National Land Archive Production System (NLAPS) script uses only the first four digits from the year column (#2) and the day of year (#3) to get the time-related information.

Band 5 Coefficients
a50=0.254503
a51=1.09271
a52=7.944

Band 7 Coefficients
a70=0.496719
a71=0.979471
a72=14.52

4.2.5 File: L5gain5a

This update will affect bands 5/7 over the lifetime of the instrument (No change for reflective bands). Previously, the gain model was tied to the cross-cal gains (b5=7.9440, b7=14.5200). Now these gains have been slightly tweaked to take icing into consideration. Thus, the new gain models are now tied to b5=8.2090, b7=14.6950. This update for the LUT will introduce a change (improvement) of three percent in bands 5 and one percent in bands 7.

Band 5 Coefficients
a50=0.262993
a51=1.09271
a52=8.209

Band 7 Coefficients
a70=0.502705
a71=0.979471
a72=14.695

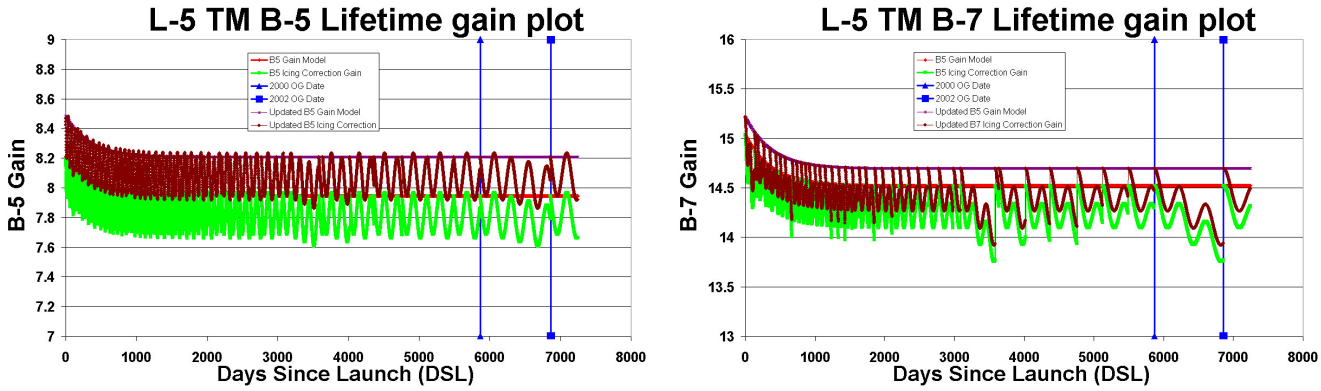

Figure 4-3. L5 TM Bands-5/7 lifetime gain plot (L5gain5a)

4.2.5.1 File: L5gain5b

The earlier LUTs were extrapolated until the end of 2003 (DSL=7245). The new LUT was created and extended until the end of 2005 (DSL=7976). The bands 5/7 icing corrections coefficients still use December12, 2002 (DSL=6861) as the last outgassing date. The LUT5a and LUT5b should be identical until DSL=7245.

The January and February 2004 data processed were calibrated using the "last gain numbers" (DSL=7245) from the current LUT. This is not a problem for bands 1-4 because the gain is a fixed number (b1=1.243, b2=0.6561,b3= 0.905, b4=1.082); however, for bands-5/7, there is an icing correction that varies each day. Since last month, we have been using a fixed gain number (b5=7.921, b7=14.492).

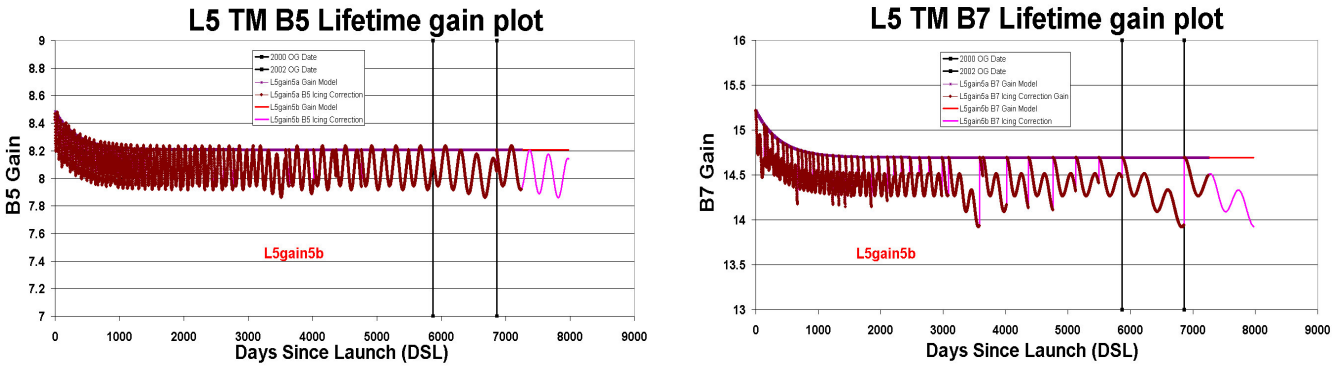

Figure 4-4. L5 TM Bands-5/7 lifetime gain plot (L5gain5b)

4.2.6 File: L5gain6a

An outgassing event took place on Mar 25, 2004 (DSL=7330), and the icing correction factors were updated to reflect this change.

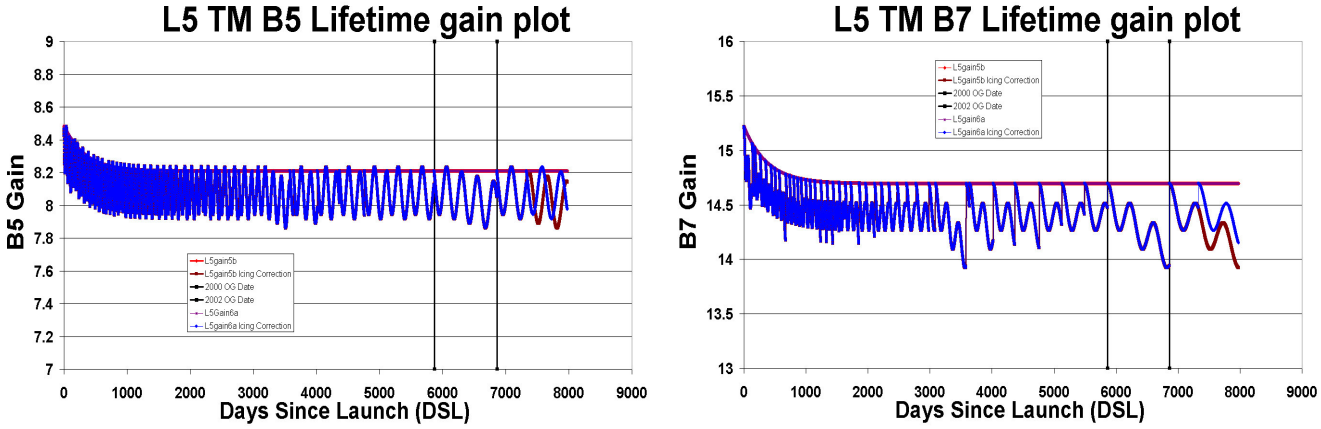

Figure 4-5. L5 TM Bands-5/7 lifetime gain plot (L5gain6a)

Table 4-1. Summary of LUT Modifications

LUT Version	Modifications
L5gain1a	No Icing Correction
L5gaib2a	Icing corrections were implemented for bands-5/7
L5gain3a	Outgassing event on Dec 12, 2002
L5gain4a	Bands-5/7 gain coefficients mirror image of L5gain3a
L5gain4b	Fraction part in column-2 refined to get true Day of Year
L5gain4c	Decimal rollover at the end of the year
L5gain5a	Bands-5/7 cross-cal gains tweaked to take icing into account
L5gain5b	LUT extended from DSL 7245 to 7976
L5gain6a	Outgassing event on Mar 25, 2004

Section 5 Operational Changes Expected

Prior to May 5, 2003, the L5 TM calibration procedure in NLAPS (previously used in TIPS) used the instrument's response to the Internal Calibrator (IC) on a scene-by-scene basis to determine the gain and offset to be applied. The implementation of the LUT-based approach will lead to a superior L5 TM data product that will be comparable to L7 ETM+ radiometery and will provide the basis for continued long-term studies of the Earth's land surfaces.

Appendix A Acronyms

CPF	Calibration Parameter File
DOY	Day of the Year
DSL	Days Since Launch
EDC	EROS Data Center
EROS	Earth Resources Observation Systems
ETM+	Enhanced Thematic Mapper Plus
GCCB	Ground Station Configuration Control Board
IAS	Image Assessment System
IC	Internal Calibrator
L5	Landsat 5
L7	Landsat 7
LUT	Lookup Table
NLAPS	National Land Archive Production System
TIPS	Thematic Mapper Image Processing System
TM	Thematic Mapper